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PLEASANT HOURS WITH THE MICROSCOPE.

BY HENRY J. SLACK, F.G.S., F.R.M.S.

IN recognising different groups of infusoria, the most obvious characteristics are afforded by their organs of locomotion, or when they are stationary, by those for seizing their food. Stein divided the ciliated kinds into four groups, which he named *Holotricha*, all over cilia; *Heterotricha*, having cilia and styles; *Hypotricha*, showing a distinction between back and front sides, the latter only ciliated; *Peritricha*, the body generally naked, but ciliated near the mouth. It is not worth while for the beginner to trouble himself much about principles of classification, but the above names represent facts of great importance to the little animals, and very interesting to observe. Specimens of all these groups are to be seen in hay infusions, and their modes of life present considerable variations. The drawings of these objects in the best works show all that can be seen under the most favourable circumstances, and all that has been seen after prolonged study and numerous observations. At first these representations bewilder the student, as many details, quite plain in the drawing, are invisible in the objects before him. For example, the star-shaped, contractile vesicle of a *paramecium* is difficult to discern while the animal is actively moving, but easily recognised as it gets quiet, and the water-drop dries up. The mouths of the smaller creatures are often unnoticeable unless food particles are seen to enter, and the nucleus and nucleolus (endoplast and endoplastule of Huxley), which probably represent male and female organs—though this is disputed, make a conspicuous show in the books, and often require a good deal of management to see plainly in the living objects.

A little carmine in the water is of great use in finding the mouth of an infusorian. The bright red particles are seen to be swallowed, and their subsequent course can be traced. When they are noticed in numerous groups, occupying small clear spaces, the most obvious explanation is that the creature possesses a plurality of stomachs, and hence Ehrenberg, the great founder of knowledge concerning them, called them *Polygastrica*, or many-stomached. Further observation showed that a stomach could be formed when required in the soft sarcode, and that even when there was a permanent gullet with thickened corrugations, no stomach existed, having a permanent place, and its own bounding membranes. Externally a ciliated infusorian has a skin, or pellicle, stiff enough to support its swimming organs. In some cases this pellicle is highly elastic, and permits great changes of shape, while in others it is unyielding and the form fixed. Amongst the *Heterotricha* the integument is strong enough to permit the bristles, or styles, to act with considerable leverage. They may often be seen to have a bulb at their base, which works in a thickened mass of the pellicle, so as to perform the function of a ball and socket joint, though it is a much simpler structure.

Below the pellicle comes a layer of elastic sarcode from which the cilia spring. The internal part is composed of protaplasm full of granules, and very soft. It is not uncommon to find protoplasm spoken of as homogeneous, but there is no such thing. Granular matter is always present, immersed in a transparent fluid. As soon as one of the ciliata has swallowed a food-particle, and transferred it to its interior, the protoplasm forms a vacuole into which it pours a digestive fluid; and when it has been sufficiently acted upon, the waste matter is excreted either through a permanent anus or through a temporary opening which closes up. Many infusoria are supplied with trichocists, or little cells, in the firm protoplasm, from which it can emit minute rods, or needles, supposed to act like the stinging organs of polyps and anemones. Simpler than the ciliated infusoria are the *flagellata*, which swim by means of one or more whips.

Mr. Saville Kent, whose "Manual of the Infusoria" is the greatest English work on the subject, and whose opinion is entitled to much weight, proposes a new division of the creatures, which we shall now describe, because it suggests interesting points for the student to look for. He includes under the name of infusoria only such protozoa, or rudimentary animals, as are furnished in their adult condition with cilia, flagella, or adhesive, or suctorial tentacles, and which take in their food by one or more distinct apertures, or at any part of their bodies. Minute animals, moving with whips, fill his section of *Pantostomata*, or universal mouth creatures; then come his *Discostomata*, which have whips, take in their food at some point in a definite anterior region, but have no mouth. After this comes *Eustomata*, well-mouthed, in which a distinct mouth exists; and lastly, *Polystomata*, or many-mouthed, which include creatures with tentacles by which they suck the contents out of their prey, or obtain it by first pouring some of their own fluid matter into the prey, and then setting up a current which brings it back laden with fresh matter.

The two systems of classification, one founded upon locomotive organs, and the other upon mouth organs, both suggest what the student should look for. The modes of reproduction should also be noticed. The commonest is by fission, either transverse or longitudinal. It is extremely interesting to see a creature split itself into two. Before the separation occurs, an internal growth takes place, so that each half departs fully organised. This method allows an amazingly rapid multiplication, so that Ehrenberg computed that a single *Stylonichia mytilus* might have a million descendants in ten days. Many of the small flagellata, or whip animalcules, form sporocysts, or capsules of spores. Mr. Dallinger found some of these spores too minute for individual recognition with a power

of 15,000 diameters. A swarm of them make a little cloud, and each one is capable of developing into the parent form. These monads have an active stage, when they move rapidly with their whips, a quieter amæboid stage, and then the sporocyst state. The cyst finally bursts, disperses its contents, and fresh generations arise to repeat the processes.

The next paper will be illustrated by figures of the principal types, and special notice of some of their habits.

THE RECENT SOLAR ECLIPSE.*

By RICHARD A. PROCTOR.

THE news received from the observers of the solar eclipse of May 6 seems to show that veritable accessions were made to our knowledge on that occasion. We learn first that the corona extended visibly to a distance of two diameters, corresponding to about 1,700,000 miles from the sun. "The light during the middle of totality," says the report, "was equal to that of the full moon," a statement which I venture to regard as a very vague guess indeed. The circumstances of a total eclipse are so unlike those under which the full moon is ever observed, that such a comparison as is suggested in the telegram is absolutely impossible. It is gratifying to learn that Dr. Janssen, whose photographic work on the sun at Meudon has long been celebrated, made successful observations. Professor Tacchini, the eminent Italian spectroscopist, was, it appears, equally successful. Dr. C. S. Hastings, the American physicist, has done good work within recent years in determining the difference between the solar spectrum obtained from different parts of the sun's disc. He has had sufficient work with the spectroscope to justify us in accepting with confidence his statement that the D line of the spectrum was seen dark in the corona. This is a most important observation. During the eclipse of 1871, Janssen recognised the solar dark lines in the spectrum of the corona; but some doubted whether the observation had been satisfactorily made. Dr. Hastings, by limiting his attention, apparently, to one particular part of the spectrum and one well-known line, has been able to place the existence of the dark solar lines in the coronal spectrum beyond any possibility of doubt. For what he has proved of one may be taken, when we consider Janssen's observation in 1871, as applying to all. Now the existence of these lines in the coronal spectrum proves that the light of the corona is in great part reflected sun light, and therefore that the corona consists in large degree of matter capable of reflecting sunlight. I take it that the meteoric and cometic theory of the corona, or rather the theory that the corona consists in large part of meteoric and cometic matter, has been thus practically established.

The extension of the corona to a distance of two solar diameters was quite as great, says an article in the *Times*, "as was expected at the period of maximum solar activity." Quite, I should imagine, as great, in fact, as could have been expected by those who, like myself, see no reason for expecting a smaller corona at the time of maximum than at a time of minimum solar disturbance. Considering that the observations were made from very near the sea-level, the observed extension of the corona corresponded to at least as great a real extension as existed in 1878, a time of minimum disturbance, when Professor Cleveland Abbe observed the coronal streamers extending, but as very faint streaks, to a distance of six diameters; for Professor Abbe was stationed some five thousand feet above the sea-level. The theory referred to in the *Times'* remark, it that the corona is farther extending and less luminous at a time of small solar activity (as indicated by the absence of sun-spots); being reduced in extent, but much brighter, when sun-spots are numerous; also, that under the latter circumstances, only, can the bright lines of hydrogen be detected in the corona. I believe that the former part of the theory is probably incorrect, but the latter may be sound enough. The records of total solar eclipses show cases of enormous coronal extension at the time of maximum as well as minimum solar activity. There are cases, also, though less frequent, when the corona has been exceedingly brilliant at the time of minimum spot disturbance. Therefore the supposed change of general character in the corona may well be doubted. It is otherwise, however, with the special peculiarity relating to the presence of glowing hydrogen in the corona. Observation and reasoning seem alike to show that hydrogen is probably either not present in such quantity or not in the same incandescent state when sun spots are few as when they are many. In the first place the lines of hydrogen were wanting during the eclipse of 1878, when the circumstances were such that, had they existed, they should have been well seen. In the second place, there is a known relation between sun spots and solar hydrogen which, to say the least, favours the idea that the observed difference should be systematically recognised. When there are few spots or none on the sun's surface, the eruptional or jet prominences are not seen. They are also limited at all times to the solar spot zones. There is, then, a real connection between the existence of spots on the sun and the occurrence of outbursts during which, whatever may be the actual nature of the erupted matter, hydrogen is observed around the sun to enormous heights above his surface, and in a state of intense incandescence. The observed peculiarities of arrangement in the solar prominences by which the jets of glowing hydrogen are limited to the spot zones and to the periods of solar activity, as manifested by spots, justify us in expecting that throughout all the brighter parts of the corona, and to a distance of at least a million miles from the sun, glowing hydrogen would be seen when spots are many. For in some of the great eruptions glowing hydrogen has been traced, without any eclipse to aid the observer, to a distance of over 200,000 miles from the sun's surface.

"The English observers were successful in obtaining photographs of the flash"—a somewhat mysterious communication at first view, but really full of interest and significance. I believe the word "flash" was invented by Mr. Lockyer. It is the rather prosaic name for a very beautiful phenomenon, the occurrence of which I predicted several months before the eclipse of December, 1870, when it was first observed. At the last moment before totality, just as the moon is about wholly to hide the disc of the sun, her edge is approaching his at a point where complete covering will just be effected. The moment after, around an arc of some extent near that point, the absorptive atmosphere to which the solar dark lines are due is for the moment shining alone. It absorbs the more glorious light of the sun; but it emits the very rays which it absorbs. When, then, to the observer with the spectroscope, the rainbow-tinted streak which forms the background of the solar spectrum disappears, the gases which produce the dark lines on that background produce bright lines on the dark background which for the moment

* From the *Newcastle Weekly Chroniole.*

replaces it. Then suddenly flashes into view a rainbow-tinted array of lines, multitudinous in number and most beautiful in aspect. (Mr. Lockyer oddly enough imagined in 1870 that the absorption took place *below* the visible surface, and therefore not only rejected the idea that they would be seen, but for a long time denied that they had been seen. However, repeated observations at last convinced astronomers that the other view was the sounder —and now these lines have even been photographed.)

OUR CHEMISTRY COLUMN.

By WILLIAM JAGO, F.C.S.

THE HALOGENS.

FROM the ordinary definition of an element as a substance which cannot be split up into two or more different substances, it follows that no two elements can be exactly alike, because they would then be one and the same element. But while we cannot take two of the elements and say that they are in every way similar, we can nevertheless arrange them into groups, between the members of which there is a strong family likeness. The classification of elements in this manner has always been a fascinating occupation to chemists, for if a group consists of three elements—say, A, B, and C—which are remarkably like one another, is it not possible that they may be modifications of one and the same element of simpler constitution than has hitherto been discovered? Of such groups, perhaps, none present such striking and interesting resemblances as that whose name heads the present article. The "halogens" include the three elements—chlorine, bromine, and iodine, of whose presence in sea-water we dealt in the last paper. The group is generally made to include another element—fluorine. This latter, however, if the others be looked on as brethren, cannot aspire to a much closer relationship than that of a first cousin. Let us confine our attention to the first three: their study can be best prosecuted by actually preparing the substances and experimenting on them. The chemical student who has a few flasks and other appurtenances of the laboratory at hand, can easily prepare for himself a few jars of chlorine. Let him, however, avoid so doing in any place where the fumes of the gas will penetrate to those who may not be enamoured of practical chemistry; for, while sulphuretted hydrogen is known everywhere as the gas with a downright stench of rotten eggs, commend us to chlorine for a gas making existence a burden in its immediate neighbourhood. Its odour is most pungent and irritating, and even a comparatively little, present in the air, makes breathing difficult; still there is this comfort about it, the fumes are not injurious to health otherwise than by their irritating action on the mucous membrane. If there is not sufficient of the gas disseminated through the air to make breathing inconvenient, no harm is being done. Curiously enough, chlorine and sulphuretted hydrogen, before referred to as the gas of rotten-egg-like odour, mutually destroy each other, producing inodorous sulphur and far less disagreeable hydrochloric acid. So, a stranger in a chemical laboratory, inconvenienced by the chlorine being made by the worker on his right, may get rid of that gas if he can only persuade some one else on his left to make sulphuretted hydrogen in just the right proportion to neutralise the chlorine. The writer, however, cannot from personal experience recommend this method of purifying the air of a laboratory or other room from chlorine; somehow or other the exact point of proper quantities seems as difficult to realise, as it is to conceive how those two disagreeable neighbours, the Kilkenny cats, managed to render a service to Kilkenny by mutually destroying each other, except the tips of their tails. This property of chlorine is, nevertheless, a useful one to remember, for in the vicinity of chemical works, where water impregnated with the gas is allowed to enter the drains, it destroys the sulphuretted hydrogen, and also is inimical to the life of disease germs. However, despite the obstacle of smell, one may manage to make the gas in either the open air (provided there is no wind) or an outhouse. For this purpose a flask, fitted with a cork and delivery tube, after the manner described in text-books for the preparation of gases, will be needed; in this flask a mixture of sulphuric acid, common salt, and manganese dioxide is placed, the flask is gently heated and the gas collected in jars over warm water. A little bromine and iodine may be readily purchased from the chemist, provided the would-be purchaser of iodine can persuade the vendor he is not a dynamiter in embryo. Some bromide and iodide of potassium should also be obtained.

And now let us see what our three elements are like; chlorine is a gas, bromine a liquid, and iodine a solid. Here there is, you see, a sort of ascending the scale through the three gradations of form in which matter is known to exist. We find, too, that in passing from chlorine to bromine, there is a deepening in colour; the former is a greenish yellow, the latter a deep red, and also, at ordinary temperatures, gives off a vapour of the same tint; iodine is also dark in colour, but if a few grains are heated in a test-tube or flask, a vapour of a superb violet hue is produced. The whole three elements have a very similar smell, but of the three, that of bromine is the worst. The name itself is derived from the Greek *bromos*, a stench. The three elements can exist in the state of vapour, and if the vapours are weighed, the density of chlorine is found to be 35·5 (hydrogen always being taken as unity), that of bromine 80, and of iodine 127; here, again, there is the same gradation. It may be noticed, in passing, that the density of bromine is almost the mean of those of chlorine and iodine. Powerful acids are formed by the union of one atom of each of these elements with one atom of hydrogen. These acids are all gaseous and all readily soluble in water, producing in this manner pungent fuming liquids. The salts of these acids with the same metals crystallize in the same shape, and are very similar in appearance; of these bodies common salt is a familiar example. The name "halogen" is applied to members of this group because of their thus forming salt-like bodies, the word literally signifying "salt-producer." As the density of the halogens increases, their chemical activity diminishes, so that in most instances chlorine is the most powerful element of the three. The two salts that have been suggested for examination, bromide and iodide of potassium, are both very soluble in water. Pour some of a solution of the bromide into one of the jars of chlorine gas that have been made, notice that the colour changes to deep red, and if sufficient bromide has been added, little red drops of bromine will be seen. In the same way, pour just a single drop of bromine in some of the iodide solution, and iodine is liberated; by adding some carbon disulphide, and shaking up, the iodine is dissolved by the disulphide, to which it imparts the same purple tint as that characterising its vapour. These experiments illustrate the principle of the method employed for the extraction of these elements from sea-water. Chlorine is passed through the "bittern" before described, and the free bromine dissolved out by ether. Iodine is obtained by burning the sea-weeds, which extract it from sea-water, and

heating the ashes, containing sodium iodide, with sulphuric acid and manganese dioxide, when the iodine distils over. Chlorine is manufactured largely for bleaching purposes. Its efficacy in this direction may be readily proved by introducing a piece of moistened red blotting-paper in a jar of the gas: the colour almost immediately disappears. Bromine and iodine have not, however, such extended applications, being principally used as medicinal agents. Perhaps among the wonderful changes resulting from chemical action there is scarcely one more remarkable than this production of the halogens from sea-salt. Common salt, so necessary as an article of food, is seen to be composed of chlorine—a gas of most poisonous nature—and sodium—which metal would certainly take fire if placed in the mouth; and yet the two combined form a body so entirely different in all its properties.

In the next article of this series it is proposed to commence the study of the chemistry of those grains, such as wheat, &c., used as articles of food, and also the chemical changes involved in the preparation from them of the numerous class of bodies in general and everyday use.

Brighton School of Science and Art.—One of the leading institutions in Brighton is the School of Science and Art. The building, which is fitted with the most recent appliances, was built at a cost of £12,000. The Science Department is under the control of our contributor, Mr. W. Jago, F.C.S. It contains a good laboratory and a lecture theatre. One of the most important aims of the institution is to provide technical education in chemistry, for intending brewers, engineers, medical men, &c. The laboratory is open daily for students of this description.

It is reported that a company has been formed in Iowa for the purpose of manufacturing sporting shot from iron. It is stated that recent trials which have been made with the shot have proved it to be fully equal, and in some respects superior, to the lead shot.

An American contemporary thus describes a piece of tunnel work which baffled the excavators from the same cause as that which gave so much trouble in the St. Gothard:—"The phenomenon of a tunnel so filling itself up as to resist all efforts to open it is reported from Virginia, Nevada. In Castle District, at a point about five miles north of that city, is a tunnel that may be called an ex-tunnel. It was run about four years ago into the side of a steep hill, and was originally about 40 ft. in length. When in about 15 ft., the tunnel cut into a soft, swelling clay, very difficult to manage. After timbering and striving against the queer, spongy material until it had been penetrated some 25 ft., the miners gave up the fight, as they found it a losing game. Being left to its own devices, the tunnel proceeded to repair damages. It very plainly showed that it resented the whole business, as its first move was to push out all the timbers and dump them down the hill. It did not stop at that, but projected from the mouth of the tunnel a pith or stopper of clay the full size of the excavation. This came out horizontally some 8 ft., as though to look about and see what had become of the miners, when it broke off and rolled down the slope. In this way it has been going on until there are hundreds of tons of clay at the foot of the hill. At first it required only about a week for a plug to come out and break off, then a month, and so on, till now the masses are ejected but three or four times a year; yet the motion continues, and to-day the tunnel has the better of the fight by about 4 ft.

THE WEATHER FORECASTS OF THE METEOROLOGICAL OFFICE.

By W. Mattieu Williams.

PRESSURE of non-postponable work has prevented me from earlier fulfilling my promise (page 72) concerning the above, in accordance with the reminder of Mr. J. W. Staniforth (page 182).

My reasons for anticipating that a fair checking of the official forecasts will prove them to be generally reliable as regards wind, but questionable in reference to rain and sunshine, are historical as well as theoretical. When I commenced, in 1854, the three science classes which laid the foundation of the now prosperous Birmingham and Midland Institute, I worked and lodged in the building of the old Philosophical Society in Cannon-street. On and in this building was one of Mr. Follet Osler's earliest self-registering anemometers, including a rain-gauge, also self-registering. The sheets on which the curves were drawn by this instrument were placed on a horizontal table. When the new Institute buildings were completed, an improved anemometer, with first-class barometer and revolving drum, instead of travelling table, was presented by Mr. Osler.

In connection with the working of these instruments I had several conferences with Mr. Osler at his house, at which he showed me the results of his researches extending over many years prior to 1854, and explained his chief object in making these observations and collating them with other observations made at Liverpool and elsewhere.

He found that certain winds most disastrous to the shipping on our coasts usually travelled in regular courses, and therefore that it was possible, by erecting a well-arranged set of observatories, easily workable with self-registering anemometers, to supply telegraphic intelligence of the approach of dangerous storms, and thus effect an important saving of life and property on our largely-navigated coasts. He did not assert the possibility of foretelling *all* the gales and squalls, one very simple reason being that storms reaching us from outside, as, of course, they generally do, must strike one part of our coast without any possible anemometer warning from British stations. (There was no Atlantic cable then). Only the stations in the following track of the storm could possibly receive a warning, and of these stations only such as were far enough distant as to get their telegraphic news before the storm arrived.

Mr. Osler struggled hard to induce the Government to take the subject in hand as a national business, and to his efforts we are largely indebted for the establishment of Admiral Fitzroy's storm warnings, and much of the present organisation of the Meteorological Office and its tributary observatories connected by a complex chain of telegrams. For the comfort of certain gentlemen, I may state that Mr. Osler was a very long way beyond the reach of any office-seeking motives in advocating this official scientific work, and that he spent on the demonstration of its desirability a considerable amount of money and of work. The money he could spare well enough, but not the work.

The prediction of rain was not an element of Mr. Osler's original scheme, and I question the policy of the Meteorological Office in the inclusion of fine, and wet, and cloudy weather in their forecasts. It looks like a bid for popularity, and is likely to defeat its own object by the number of failures that must inevitably occur in a country like ours, where it is possible by means of local observations to contradict any general prediction, however accurate it may be in its generality. The districts included in the forecasts are so large that during certain very common conditions of

British weather there shall be at one place within such district no rain at all, in another an abundance of rain; therefore, whether the forecast says rain or no rain, it may be refuted by one place or the other. Where I live, for example, it is commonly the case at about this time of the year that refreshing showers may be seen falling on the ridge of Dollis Hill, about a mile distant, while my garden, and those of my neighbours, are starving from drought.

There are, on the other hand, times when the whole island is under one great pall of cloud, or enjoying continuous sunshine. The weather predictions of the Meteorological office, as recorded in the newspapers, are then almost invariably correct. I think it would be far better if the predictions of rain, cloud, and sunshine were limited to these periods, even though the newspapers should cease to quote them in consequence, and the picnicing interests be alienated. The shipping interests would still be equally well served, and those of science somewhat better, while the office itself would hold a higher position than under its present exposure to flippant criticisms, based upon failure in the prediction of contradictory variations of local meteorological details by critics whose acquaintance with the daily reports of the Meteorological Office is limited to the fragment copied by the newspapers, which usually omits the most important elements of the report—viz., the barometric gradient and the wind curves—for the sufficient reason that their readers cannot understand them.

I should add that the establishment of the general reliablility of Buys Ballot's law has supplied an important supplement to Osler's method of forecast. This law is that (in the Northern hemisphere) if you know the barometric gradient and stand with your left hand towards the region of low barometer and right to high, the wind will blow against your back, not quite squarely, but a little on the right side. The barometric gradient is obtainable by telegraphic intelligence of the state of the barometer at different meteorological stations, whereby a line may be drawn from the highest barometer to the lowest, or along the slope of this gradient. Like Osler's method, it only tells directly of the winds, but indirectly and doubtfully of sunshine, cloud, and rain.

HERR F. SCHELL, of Grund, has described some observations recently made in the course of mining work in the Hartz Mountains, on the distance through which sounds are transmitted in rock. In a horizontal direction the firing of shots at the face of a cross-cut has been heard in a cross-cut driven toward it, the face of which was 447 ft. distant from it. A level was driven on a vein at a depth of 538 ft. below the surface, and happened to strike 187 ft. distant in a horizontal direction below a stamp-mill dropping stamps weighing 330 lb. The dropping of the stamps on the surface could be distinctly heard in the heading below, which, in a direct line, the hypothenuse of a right-angled triangle, was separated by 571 ft. of rock.

THE *Railway Review* (Chicago) quotes from the *Picayune* a description of a remarkable creosoted trestle which the New Orleans and North-Eastern Railway is building across Lake Pontchartrain. It will be $21\frac{1}{2}$ miles long, $5\frac{3}{4}$ miles of which will be over the lake. Of this portion of the work the piling has been driven for $2\frac{1}{4}$ miles, and one mile is completed. The piles average 60 ft. in length, and are driven in for about 40 ft. The whole structure is exceedingly substantial, and is said to be a most perfect specimen of trestle work. Some idea of the magnitude of the undertaking may be gathered from the fact that the quantity of timber required, besides the piles, will be over 15,000,000 ft.

THE BIRTH AND GROWTH OF MYTH.

BY EDWARD CLODD.

X.

ALTHOUGH in the Vedic hymns the features of the primitive nature-myth reappear again and again, Indra himself boasting, "I slew Vritra, O Maruts, with might, having grown strong with my own vigour; I who hold the thunderbolt in my arms, I have made these all-brilliant waters to flow freely for man," we find an approach in them to some conception of that spiritual conflict of which the physical conflict was so complete a symbol. Indra, as victor, is an object of adoration and invested with purity and goodness; Vritra, as the enemy of men, is an object of dread, and invested with malice and evil.

But while in the Zend-Avesta, the Scriptures of the old Iranian religion, the struggle between Thraetaôna and the three-headed serpent Azhi-Dahâka (in which names are recognisable the Traitana and Ahi of the Veda and the Feridum and Zohak of Persian epic) is narrated, the normal idea is dominant throughout. The theme is not the attack of the sun-god to recover stolen milch cows from the dragon's cave, but the battle between Ormuzd, the Spirit of Light, and Ahriman, the Spirit of Darkness. The one seeks to mar the earth which the other has made. Into the fair paradise, Airayana-Vaêjô, "a delightful spot," as the Avesta calls it, "with good waters and trees," and into other smiling lands which Ormuzd has blessed, Ahriman sends "a mighty serpent . . . . strong, deadly frost . . . . buzzing insects, and poisonous plants . . . . toil and poverty," and, worse than all, "the curse of unbelief."* Between these two spiritual powers and their armies of good and bad angels the battle rages for supremacy in the universe for possession of the citadel of Mansoul.

Early in the history of the Aryan tribes there had arisen a quarrel between the Brahminic and Iranian divisions. The latter had become a quiet-loving, agricultural people, while the former remained marauding nomads, attacking and harassing their neighbours. In their plundering inroads they invoked the aid of spells and sacrifices, offering the sacred soma-juice to their gods, and nerving themselves for the fray by deep draughts of the intoxicating stuff. Not only they, but their gods as well, thereby became objects of hatred to the peaceful Iranians, who forswore all worship of freebooter's dieties, and transformed these *devas* of the old religion into demons. That religion, as common to the Indo-European race, was polytheistic, a worship of deities each ruling over some department of nature, but a worship exalting now one, now another god, be it Indra, or Varuna, or Agni, according to the indications of the deity's supremacy, or according to the mood of the worshipper. As remarked by Jacob Grimm, "the idea of the devil is foreign to all primitive religions," obviously because in all primitive thought evil and good are alike regarded as the work of deities. In the Old Testament, Yahweh is spoken of as the author of both;† the angels, whether charged with weal or woe, are his messengers. In the "Iliad," Zeus dispenses both:—

> "Two urns by Jove's high throne have ever stood,
> The source of evil one, the other good;
> From thence the cup of mortal man he fills,
> Blessings to these, to those distribute ills,
> To most, he mingles both."‡

and 'tis a far way from this to the loftier conception of Euripides: "If the gods do evil, then are they no gods

* Haig's "Essays on the Parsis," tr. Vendidâd, pp. 225, ff.
† Cf. Isaiah xlv. 7; 1 Kings, xxii. 21-23.
‡ Iliad, Book xxiv, p. 663 ff., Amos iii. 6.

XUM

So there was a monotheistic—or, as Prof. Max Müller terms it, a henotheistic—element in the Vedic religion which in the Iranian religion, and this mainly through the teaching of the great thinker and reformer, Zarathushtra (Zoroaster), was largely diffused. In his endeavour to solve the old problem of reconciling sin and misery with Omnipotent goodness, he supposes "two primeval causes," one of which produced the "reality," or good mind; the other the "non-reality," or evil mind. Behind these was developed belief in a philosophical abstraction, "uncreate time," of which each was the product; but such doctrines were too subtle for the popular grasp, and, wrapped in the old mythological garb, they appeared in concrete form as dualism. Vritra survived in Ahriman, who, like him, is represented as a serpent; and in Ormuzd we have the phonetic descendant of Ahura-mazdas.

Now, it was with this dualism, this transformed survival of the sun and cloud myth, that the Jews came into association during their memorable exile in Babylon. Prior to that time, their theology, as hinted above, had no devil in it. But in that belief in spirits which they held in common with all semi-civilised races, as a heritage from barbarous ancestors, there were the elements out of which such a personality might be readily evolved. Their *satan*, or "accuser," as that word means, is no prince of the demons, like the Beelzebub of later times; no dragon, or old serpent, as of the Apocalypse, defying Omnipotence and deceiving the whole world; but a kind of detective who, by direction of Yahweh, has his eye on suspects, and who is sent to test their fidelity. In all his missions he acts as the intelligent and loyal servant of Yahweh. But although therefore not regarded as bad himself, the character and functions with which he was credited made easy the transition from such theories about him to theories of him as inherently evil, as the enemy of goodness, and, therefore, of God. He who, like Vritra, was an object of dread, came to be regarded as the incarnation of evil, the author and abettor of things harmful to man. Persian dualism gave concrete form to this conception, and from the time of the Exile we find Satan as the Jewish Ahriman, the antagonist of God. Not he alone, for "the angels that kept not their first estate" were the creatures of his evil designs, creatures so numerous that "every one has 10,000 at his right hand and 1,000 at his left hand, and because they rule chiefly at night no man should greet another lest he should salute a demon. They haunt lonely spots, often assume the shape of beasts, and it is their presence in the bodies of men and women which is the cause of madness and other diseases." *

From the period when the Apocryphal books, especially those having traces of Persian influence, were written,† this doctrine of an archfiend with his army of demons received increasing impetus. It passed on without check into the Christian religion, and wherever this spread the heathen gods, like the *devas* of Brahminism among the Iranians, were degraded into demons, and swelled the vast crowd of evil spirits let loose to torment and ruin mankind.

This doctrine of demonology, it should be remembered, was but the elaborated form of that ancestral belief in spirits referred to above. In the Christian system it was associated with that belief in magic which has its roots in fetishism, and from the two arose belief in witchcraft. The universal belief in demons in early and mediæval times supplied an easy explanation of disasters and diseases; the sorcerers and charm-workers, the wizards and enchanters, had passed into the service of the devil. For power to work their spite and malevolence, they had bartered their souls to him, and sealed the bargain with their blood. It was enough for the ignorant and frightened sufferers to accuse some poor, mis-shapen, squinting old woman of casting on them the evil eye, or of appearing in the form of a cat, to secure her trial by torture and her condemnation to an unpitied death. The spread of popular terror led to the issue of Papal bulls and to the passing of statutes in England and in other countries against witchcraft, and it was not until late in the eighteenth century that the laws against that imaginary crime were repealed.

There is no sadder chapter in the annals of this tearful world, than this ghastly story of witch-finding and witch-burning. Sprenger computes that during the Christian epoch no less than *nine millions* of persons, mostly women of the poorer classes, were burned; victims of the survival into relatively civilised times of an illusion which had its source in primitive thought. It was an illusion which had the authority of Scripture on its side;* the Church had no hesitation concerning it, such men as Luther, Sir Thomas Browne, and Wesley never doubted it, the evidence of the bewitched was supported by honest witnesses, and judges disposed to mercy and humanity had no qualms in passing the dread sentence of the law on the condemned.†

And although it exists not to-day, save in bye-places where gross darkness lurks, it was not destroyed by argument, by disproof, by direct assault, but only through the growth of the scientific spirit, before which, like the miasma of the Campagna or the planting of the Eucalyptus, it has dispersed. It could not live in an atmosphere thus purified, an atmosphere charged with belief in unchanging causation, and in a definite order unbroken by caprice or fitfulness, whether in the sweep of a planet or the pulsations of a human heart.

Of course the antecedents of the arch-fiend himself could not fail to be the subject of curious enquiry in the time when his existence was no matter of doubt. The old theologians scraped together enough material about him from the sacred books of the Jews and Christians to construct an elaborate biography of him; but in this they would seem to have explained too much in certain directions and not enough in others, thus provoking a reaction which ultimately discredited their painful research. Their genealogy of him was carried further back than they intended or desired, for the popular notions credited him with both a mother and grandmother. Their theory of his fall from Heaven gave rise to the droll conception of his lameness and to the legends of which the "devil on two sticks" is a type. Their infusion of foreign element into his nature aided his pictorial presentment in motley form and garb. To Vedic descriptions of Vritra's darkness may perchance be traced his murkiness and blackness; Greek satyr and German forest-sprite his goat-like body, his horns, his cloven hoofs, his tail; to Thor his red beard and trident, vulgarised into a pitchfork; to dwarfs and goblins his red cloak and nodding plume; to theories of transformation of men and spirits into animals his manifold metamorphoses, as black cat, wolf, hellhound, and the like.

But his description was his doom; it was by a natural sequence that the legends of mediæval times present him, not, with the Scotch theologians, as a scholar and a swindler, disguising himself as a parson, but as gullible and stupid,

* Vide my "Jesus of Nazareth," p. 144.

† Notably "Tobit" and "Baruch," and cf. "Book of Wisdom," II. 24, for earliest indications of the belief. The Asmodeus of Tobit iii. 8 and 17, appears to be the Aeshmô dârvô of the Zend-Avesta.

* Exodus xxii. 18.

† For details of witch trials in this island, cf. Mrs. Lynn Linton's "Witch Stories," *passim*.

as over-reaching himself, and as befooled by mortals. And, like the Trolls of Scandinavian folklore who burst at sunrise, it needed only the full light thrown upon his origin and development by the researches of comparative mythologists to dissipate this creation of man's fears and fancies into the vaporous atmosphere where he had his birth.

THE FISHERIES EXHIBITION.

NATURAL HISTORY DEPARTMENTS.

BY JOHN ERNEST ADY.

II.

THE student of natural science will search in vain for an adequate representation of the class *Rhizopoda* amongst the extensive collections in the Exhibition; yet the members of this group play so important a part, not only as food and as affecting the conditions of existence of all kinds of fish, but also in the structure of the crust of the earth in times past and present, that a general record of some of the facts connected with their systematic position and life-history ought to find a place here.

It is now some years since Huxley gave the name *Bathybius* to what he then believed to consist of irregular, formless masses of protoplasm diffused over the floor and at great depths of the sea, and, more recently, Bessels described a similar structure under the name *Protobathybius*. The reports of the *Challenger* naturalists have taught us that, even at enormous depths, the conditions are not incompatible with the existence of highly-organised forms of life; the question then naturally arises, What do these creatures live upon? The ready answer would be *Bathybius!* During the cruise of the *Challenger*, Murray was struck with the development of a material, in the bottles of spirit into which specimens had been dropped freshly after capture, and which strongly called to mind Huxley's *Bathybius;* the material was not there at first, but accumulated with time. This led him to make a few experiments, and to discover that a natural process of chemical precipitation was going on in the sea whereby a gelatinous product, similar to that which was collecting artificially in the bottles of spirit, resulted in the protoplasmoid substance *Bathybius*, which, on chemical analysis, was shown to consist of sulphate of lime. We can scarcely, however, credit Herdman's unique *Abyssascidia Wyvillii*,* which was brought to light from a depth of 2,600 fathoms, with the faculty of deriving sustenance from a gelatinous precipitate of pure sulphate of lime. Doubtless there are primitive forms of life, belonging to the *Rhizopoda*, which contribute to the bodily wants of the abyssal fauna.

In our description of the *Amœba*, we chose a typical example (*Amœba princeps*) wherewith to illustrate the structure and life-history of the group. It now remains to be added, that such a form as *Amœba* may pass into one in which the pseudopodial area becomes restricted (*Pamphagus*), or it may develop a firm membraneous carapace (*Arcella*), or the carapace thus formed may be strengthened with adventitious particles, such as grains of sand, &c., (*Difflugia*).

This naturally leads to the next order of the *Rhizopoda*, viz., the *Foraminifera;* where, in addition to the structures enumerated in the *Amœba*, the forms are characterised by the presence of an arenaceous, chitinous, or, more commonly, a calcareous test, often of great beauty, and, which we noted before, plays an important part in the formation of the earth's crust.

The *Foraminifera*, with but few exceptions (*e.g.*, *Gromia*, which is found in both fresh and salt water), inhabit the sea, and all the known recent forms are of microscopical dimensions. In ancient times, however, they attained relatively gigantic proportions, as in the Eocene *Nummulites*, which in days gone by were stated by certain learned persons to be the remains of an ancient Egyptian currency. These Nummulites are often an inch in diameter, and the Cretaceous *Parkeria* is sometimes twice that size. In still remoter times, in fact, in the most ancient formations of the geological record, the Laurentian rocks of Canada, a curious structure has been described as a gigantic Foraminifer, under the name of *Eozoon Canadense*. A great deal of dispute has arisen respecting the true nature of Eozoon; it has been claimed by petrologists as of inorganic origin, and is said by them to be the mere metamorphosed results of a purely mineral aggregate or rock. The dispute has not, by any means, been satisfactorily settled, and it would, therefore, be out of place for us to enter into any detailed account of it here. Suffice it to say that similar structures have been observed in several of the so-called marbles and serpentines of the continent of Europe, and also quite recently by Heddle in Sutherlandshire.*

If to the body of an *Amœba*, devoid of any distinct separation into ecto- and endo-plasm, we add a delicate subexternal shell, composed of a horny or calcareous material, perforated in such a manner as to permit the escape of its pseudopodia, and provided with spines, we shall then have a typical Foraminifer. The shell is generally pierced by a number of minute pores, or may contain but one large terminal aperture; through these the pseudopodia, which are generally filamentous and interlacing protrude, and a thin layer of the protoplasm of the body, moreover, forms a superficial stratum over the surface of the test. The protoplasm of the body is usually of a bright yellowish hue, and exhibits a peculiar circulation of granules, analogous to that which may be observed in certain plants.†

In accordance with the perforation of the walls of their tests, *Foraminifera* have been divided into two great groups, the *Perforata* and *Imperforata*. The nature and form of the shell was long accepted as the foundation on which the classification of this interesting group was based, whilst the more important factors in their development were disregarded, because they were not understood; now that they have been partially revealed, the artificial classification promulgated by Max Schultze has given place to others more in accordance with observed facts, and the natural systems of Reuss and of Carpenter, Parker, and Rupert Jones, are now generally in vogue. The latter divides all *Foraminifera* thus:—

(To be continued.)

* Proc. Royal Soc. Edin., 1879-80, p. 470.

* Professor Heddle's report on the rock has not yet been published, but will appear shortly in the *Mineralogical Magazine*.—J. E. A.

† We may here draw the attention of the reader to Mr. Bolton's table, stand 756, once more. Under one of the microscopes he will notice a specimen of the proembryo of *Nitella*, showing the circulation alluded to above.—J. E. A.

SUN-VIEWS OF GREAT BRITAIN.

WE give this week what may be called Sun-Views of Great Britain, showing how the aspect of Great Britain and Ireland, Norway, Denmark, France, Spain, &c., varies, as supposed to be seen from the sun.

Fig. 1. At noon, midwinter.

Fig. 2. At noon, in spring or autumn.

Fig. 3. At noon, midsummer.

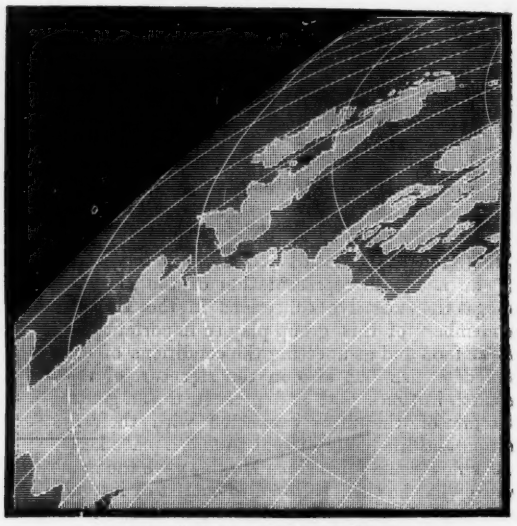


Fig. 4. At six in the morning, midsummer.

Fig. 5. At six in the evening, midsummer

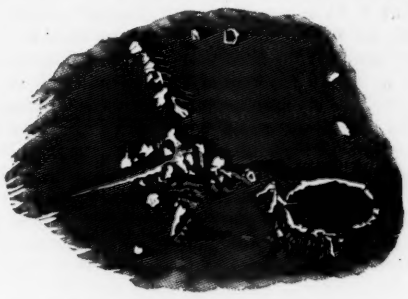
THE MOON IN A THREE-INCH TELESCOPE.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

TO the north-west of Cassini (described on p. 326) lie the Lunar Alps (80 in our map), a range of mountains possessing a much more terrestrial character than the majority of objects visible on the moon's surface. They start from the neighbourhood of Cassini, and extend with a very remarkable interruption, immediately to be spoken of, nearly, if not quite, to Plato. The interruption of which we have just spoken takes the form of an enormous wedge-shaped valley, between eighty and ninety miles long, and varying in width from three and a-half to six miles. Our sketch represents this region as it appears with a power of 120, the age of the moon being 7·58 days.

The eastern side of the valley is the steeper of the two. The highest of the mountain masses lie to the west of the huge cleft, the eastern range, however, increasing in magnitude as it approaches Plato (132). The sun was just rising on this last-named superb formation at the time our

drawing was made; and its interior, as will be seen, was plunged in the blackness of night. While scrutinising this part of the moon's surface, the student may direct his attention to the two interesting ring-plains to the North—Archytas (46) and Timæus (170). Plato itself, and its vicinity, present a most interesting region for examination during the seventh, eighth, ninth, and tenth days of the moon's age; as they do (though at a most inconvenient hour) when she is twenty-one or twenty-two days old. This great walled plain measures sixty miles across, and is notable, when fully illuminated, for its steel-grey tint. Its surrounding wall is broken in places, and exhibits very little of that series of descents in terraces which we shall find by and by in Eratosthenes, Copernicus, &c. A variety of streaks and spots have been



The Valley of the Alps, and Sunrise on Plato.
Moon's Age 7·58 days.

detected upon the very level floor by the aid of large and powerful telescopes; but by far the larger proportion of these details are hopelessly beyond the reach of the observer with such an instrument as that whose use is presupposed in these papers. Under suitable illumination, the shadows of three huge peaks on the western wall will be seen cast upon the floor; as will that of an even higher one from the eastern wall out on to the very broken surface of the Mare beyond. It is, so far, an inexplicable fact, that, as the Sun rises on the interior plain of Plato, it follows the usual law of getting brighter until the Sun has attained an altitude of 20°, or thereabouts; after which it darkens very notably and perceptibly until shortly after full Moon. South of Plato stands that absolutely isolated peak, Pico (131), in the dark grey Sea of Showers. As it is some 8,000 feet in height, it casts a tremendously long shadow under the oblique illumination either of sunrise or sunset, and forms a most conspicuous object. Timocharis (121) is worth looking at for its terraced wall. The glorious mountain Chain of the Apennines (85, 87, 92, in our map) presents, like the Alps of which we have spoken above, a very decidedly more terrestrial character than the vast majority of lunar objects. We may regard this superb range as starting in the north from Cape Hadley (87), which rises more than 15,000 feet from the plain at its base, although they will be seen to tend in a south-westerly direction from it. Following them, however, in their eastern course round the Sea of Showers, we come to Bradley (89), a mountain 13,600 feet in height, and to Huyghens (90), the loftiest of their peaks, attaining an altitude of some 20,000 feet. The spectacle presented by this range of mountains—for the observation of which a power of 160 may be employed on a fine night—with their glittering and corrugated highlands, and the serrated shadows cast by their peaks on the plain beneath, is a wonderfully beautiful one, and will repay the most earnest attention the student can give to it. The projection of this noble ridge beyond the illuminated part of the moon, about the time of first quarter, is easily discernible with the naked eye by moderately sharp-sighted people. It may be held to terminate with Eratosthenes (110), the description of which, however, we must reserve for our next paper.

Editorial Gossip.

THE present number completes Vol. III. The Index and Title-page will shortly be published,—separately, because it is not thought just to force those who read but do not keep KNOWLEDGE to pay for an index which is of no use to them. The plan involves some loss to the proprietors, but it is followed as the fairest.

ORIGINALLY it had been intended to have but a single volume for each year, but it was pointed out that such volumes would be cumbrous, especially when the growth of our circulation rendered possible an increase in the size of each monthly part. But readers should remember that the promises made for Vol. III. related to what will in reality be Vols. III. and IV.

DR. WILSON'S papers on "Our Bodies" being concluded, he has promised a series on our remote kinsfolk, the more or less man-like monkeys. These will shortly, we trust, be commenced. The valuable papers on the Moon, by F.R.A.S., commenced in Vol. III., will be continued in Vol. IV. They are likely, we trust, to form for a long time a feature of KNOWLEDGE. (Some correspondents pay us the high compliment of identifying F.R.A.S. with Mr. R. A. Proctor, who is a fellow of the same society, but is not the writer of those interesting papers, nor of anything which has appeared over the signature F.R.A.S., here or elsewhere.) A series of papers sketching Mr. Herbert Spencer's "Philosophy of Society" will shortly be commenced by Mr. Thos. Foster. Mr. Grant Allen will continue his interesting series, "A Naturalist's Year"; Mr. H. J. Slack his valuable "Hours with the Microcosope"; Mr. W. Mattieu Williams the useful series now in progress. Messrs. Slingo and Jago will supply papers on electrical and chemical subjects, the latter dealing specially with the chemistry of common life. The articles on "How to get Strong" will immediately be resumed. The "Sun Views of the Earth" will be continued, and a series of papers on the Spectroscope be presently commenced by the Editor. Chess will continue to be conducted by Mephisto, Whist by "Five of Clubs."

READERS of KNOWLEDGE will, we trust, hear with pleasure that our circulation has been steadily increasing, and promises to increase at an increasing rate. We heartily thank those who, by securing new subscribers, have helped this progress. So many have written to us that they have done so, that we have not had space or time to thank them individually. But we are none the less sensible of their good-will.

THE race of grumblers, by-the-way, seems to have died out. As we really have been doing our utmost to make KNOWLEDGE worthy of the welcome given to it, this is as it should be.

I RATHER wonder no one has called my attention to the way in which, in the gossip about printers' commas, the

gender of the French *bête* was made masculine. It is an old joke that our gallant neighbours make the uncomplimentary word feminine. I happen to remember thinking of this as I wrote, and rather carefully penning the words *bêtes noires*. Yet many to whom French is nearly as familiar as English are occasionally loose in the matter of genders. Witness Charles Reade, and the fun he made of the anonymuncules of the press, who, laboriously turning over the pages of a French dictionary, corrected him for two or three such slips in a language of which he had forgotten more than probably the lot of them ever knew (which is not saying he had forgotten very much either).

I AM asked by a correspondent, who takes great (and effective) interest in philological questions, to quote the passage where Reade uses the word anonymuncule. He has used it rather freely; but I think he first defined it in a letter to the editor of the *Daily Globe*, Toronto, in which also he defined the criticaster, the sham-sample swindler, the prurient prude, and other creatures, studied under the heading "Literary Zoology." Here is his account of "True Anonymuncule":—

> This little creature must not be confounded with the anonymous writers who supply narratives of current events, and discuss public measures with freedom, but deal largely in generalities, and very little in personalities. These are the working bees, that gather honey for the public. Reade's anonymuncule is no great producer. He can do little but sting. He is of two kinds—the anonymous letter-writer, pest of families, and the anonymous literary detractor, pest of the fine arts. Both varieties have this essential trait in common—they abuse the shelter and the obscurity of the anonymous. The literary anonymuncule often abuses it doubly—he belies his superior in one organ of criticism, then flies to another, and says the same thing in other words. Then the duped public believes that two disinterested judges have condemned its favourite, whereas the poor editors are only a couple of unguarded puppets, pulled by one unscrupulous anonymuncule raging with literary envy.

Suffering also, I imagine, under the sense that let him spit venom as he may, more remains than the anonymuncule can ever get rid of. Imagine, in this aspect, the hopeless condition of those whom we are apt to despise instead of pitying, as we should. What a sad and singular life, for instance, a skunk's must be!

MR. J. CHARLES KING, engineer, sends us his pamphlet suggesting a land junction between Great Britain and Ireland by a tunnel connecting Antrim and the Mull of Cantire. We fear to discuss the subject, lest we should be told that there is imminent danger to our tottering country in a tunnel so situate. One wonders what our kindred in America and Australia think of these fears? It used to be—

> Come the three corners of the world in arms,
> And we shall shock them.

It is some comfort to reflect that only about $\frac{1}{1000}$th (or, to be more precise, $\frac{1}{1024}$th) of the blood of the chief warrior who thinks England effete is English—or rather, is of that complex mixture of Norman, Scottish, English, French, German, and Italian blood, which attained its fullest development in James, known as the First of England and the Sixth of Scotland,—but to his familiars by a less dignified title.

BY the way, what were, in Shakespeare's time (or John's, if the saying was meant for the earlier date), the "three corners" of the world?

LOOKING over some early proof sheets of the Philological Society's new English Dictionary, kindly sent me by a correspondent, I came across the following, under the word "Almanac," which is interesting in connection with my views respecting the Great Pyramid.

> Eusebius, *De Præp. Evangel.* iii. 4, quotes Porphyrius as to the Egyptian belief in astrology, in horoscopes, and so-called lords of the ascendant, whose names are given in the *almenichiaká* (*ἐν τοῖς ἀλμενιχιακοῖς*), with their various powers to cure diseases, their risings and settings, and their presages of things future.

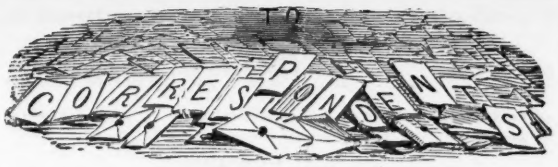
SEVERAL correspondents have asked me, by the way, since that book appeared, whether I have noticed that several eminent Egyptologists assert very positively that the Great Pyramid was meant for a tomb, and a tomb only. I know it, and knew it before. They give abundant evidence in favour of the first part of their propositions, but I have never seen a line of evidence or of reasoning in favour of the second; so that to my mind this part (namely, the *solely*-tombic theory) seems to me as illogical as the solely-temple theory, the solely-stone-bible theory, the solely-astronomical-observatory theory, and others, which are disproved by facts. Only those familiar with the difficulties and niceties of astronomical observation can know how certainly the Great Pyramid is shown to have been an astronomical observatory, whatever else it was; yet it would be utterly illogical to reject on that account the evidence which proves that the building was meant to be a tomb also.

A LONG-LIVED LAMP.—A contemporary states, on the authority of the Edison Co., that one of the B (eight-candle) lamps used in the Strasburg station installation has been burning over 5,000 hours. The same source also states that the company's manager intends to make a series of experiments with this lamp, and to publish the results.

AN extensive bed of superior red marl, 64 yds. deep, has been recently discovered at Ruabon, and with it Messrs. Monk & Newell, of Liverpool, are forthwith commencing the manufacture of terra-cotta, &c., upon a large scale, the manager of the Penybout Works—the originator of Ruabon "deep-red terra-cotta"—undertaking the practical management of the works.

THE following is the estimated railway mileage of the world, Jan. 1, 1883:—United States, 113,000 miles; Europe, 109,000; Asia, 8,000; South America, 7,000; Canada, 8,500; Australia, 3,200; Africa, 2,200; Mexico, 2,100. Grand total, 253,000 miles. These figures are not claimed to be exact. It is absolutely impossible to obtain official returns for the same period within a year or two after date, and so it is necessary to use the latest available statement, and add the probable increase since that time.

SOUTH AMERICAN TIMBER.—Some investigations by M. Thanneur show that South America is rich in woods for engineering purposes. The yandubay is exceedingly hard and durable; the couroupay is also very hard and rich in tannin. The quebracho is, however, more interesting than any, and grows abundantly in the forest of La Plata and Brazil. It resembles oak in the trunk, and is used for railway-sleepers, telegraph-poles, piles, and so on. It is heavier than water, its specific gravity varying between 1·203 and 1·333. The colour at first is reddish, like mahogany, but grows darker with time Being rich in tannin, it is employed for tanning leather in Brazil, and has recently been introduced for that purpose into France. A mixture of one-third of powdered quebracho and two-thirds of ordinary tan gives good results.—*Engineering.*



"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO, DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

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NO COMMUNICATIONS ARE ANSWERED BY POST, EVEN THOUGH STAMPED AND DIRECTED ENVELOPE BE ENCLOSED.

FLIGHT OF VERTICAL MISSILES.

[853]—I am always grateful when you give me a chance to exercise my small wits on a problem, and I offer a solution of the one with the above title [827, p. 315]. I do this with some doubt, occasioned by your exclamation point appended to the answer of 71 ft., where you seem to imply that this is more out of the way than 0·25 feet is. According to my calculation, it is about half as large again as it should be.

The initial velocity being 1,000 feet per second, I suppose the ball would ascend upward, for $\frac{1000}{32\frac{1}{6}} = \frac{6000}{193}$ seconds, and that the total rise would be $\left(\frac{1000}{32\frac{1}{6}}\right)^2 \times 16\frac{1}{12} = \frac{3000000}{193}$ feet. The average elevation during flight I make to be two-thirds of the total height, or $\frac{2000000}{193}$ feet. Now, in the time of rise and fall, the earth moves east $\frac{3000'}{193}$. During the same time the ball moves east with the velocity of a point on the earth's surface. Hence, as compared with the starting-point, the ball moves west a distance equal to the difference between an arc of $\frac{3000'}{193}$ measured at the surface, and the same arc measured at a height of $\frac{2000000}{193}$ feet, which is equal to the length of the same arc in a circle of $\frac{2000000}{193}$ feet radius. This I reduce to $\frac{10000000\,\pi}{18 \times 193^2}$, or about 46·84 feet. This would, however, be the difference of longitude measured at the height of $\frac{2000000}{193}$ feet. At the surface it would be a little less, say 46·82.

I shall wait with some curiosity for other solutions of this problem, as I should like to see whether I am right, or where I have gone wrong. ALGERNON BRAY.

[Mr. Bray's solution is quite correct. I will give next week a solution of the general problem, which I had written before his letter reached me. With regard to my exclamation point, it was appended under the idea that a rise and fall of 1,000 ft. were mentioned in the problem, instead of a velocity of 1,000 ft. per second, as I should have seen if I had read the letter over again.—R. P.]

RATIONAL DRESS.

[I hasten to publish Mrs. King's letter, because I appear to have done her injustice. I think, however, I probably used the word "fashion" in a different sense from that in which she employs it—a less extreme sense. I heard only a small part of the lecture, having an engagement which took me elsewhere.—R. P.]

[854]—As you have seen and heard me lecture, I am surprised at the view you take of my advocacy of dress reform.

My 5th requirement of a perfect dress is that it should "not depart too conspicuously from the ordinary dress of the time." I declared this to be a maxim for all time, as involving the principle of evolution; and that by the neglect of this principle we put ourselves too much out of harmony with our surroundings. I attributed the failure of Bloomerism to its having so departed. I quoted the following passage from Emerson's Essays:—"Many a good experiment, born of good sense, and destined to succeed, fails, only because it is offensively sudden. I suppose the Parisian milliner, who dresses the world from her imperious boudoir, will know how to reconcile the Bloomer costume to the eye of mankind by interposing the just gradations." "This," I continued, "is our mission, to bridge over this distance 'by interposing the just gradations,' not to Bloomerism itself, but to what was really desired in Bloomerism—a free, convenient, and comfortable dress, with the one indispensable condition added, which they seem to have left out—namely, beauty."

True, I attributed the slow progress we had made during the last two years to "the mistaken policy of concealment which had been adopted," because it is a fact which none can gainsay that apparent failure leads to failure, and apparent success leads to success, as every politician knows when he cries up the "immense success" of his party, and proclaims the "utter failure" of his opponents. But I hastened to guard against misapprehension by adding: "Let me guard against misapprehension. I do not insist upon it that every woman who joins this Association should immediately put herself into trousers, and show about three or four inches of them, as I do. The 'just gradations' must be observed in mind, as well as in act. *All I ask is that they should study certain principles, and endeavour to carry these out as far as their position, circumstances, and feelings will allow.*" This I consider the very keynote of my method of dress reform, and I would rather have this carried out both by men and women than see every woman in England wearing trousers.

Your advice to ladies to follow fashion in a sensible manner is the very worst that could be given to those who have dress-reform at heart. The sensible women who thus conform to fashion are its very mainstay and support, for it is they who "reconcile the eye of mankind" to all that in dress is born of nonsense and unreason; because ladies of good taste and refinement follow fashion a little, young fools follow it yet a little more, old fools more still, and bad fools in any way and every way they can, so as to attract attention to their persons. If fashion were left to the last two classes, it would become so notoriously ridiculous and odious that it would speedily ensure its own ruin.

I have had to thank you for the very first favourable press criticism on dress-reform which we received, and am, therefore, more sorry that you appear to have misunderstood me, for I do *not* attribute to you "the mistaken policy of concealment."

My fifth requirement is really the knotty point of dress-reform, and should you consider it worth having, I should be glad to contribute a short article upon it for your journal. E. M. KING.

[I should be very much obliged to Mrs. King if she would do so.—R. P.]

[855]—I should feel deeply indebted could you make it convenient to spare me the space of a few lines in which to reply to the arguments (?) of "A Woman," and to refute the calumnies she has cast on our dress.

It generally happens that people make egregious mistakes when presuming to instruct others in subjects of which they are ignorant—or, at best, *can* have but studied theoretically; and, as I shall endeavour to show, "A Woman" proves no exception to the rule. In her letter to the *Times* (reprinted in No. 83 of KNOWLEDGE), she treats of the matter from a threefold point of view—viz., as to health, convenience, and grace. This seems to be a very convenient method, and I propose answering her arguments in the order in which they are given.

Very properly, as I think, she avoids going into the first question in all its details, and contents herself with the remark that there has of late been a great increase amongst young men of liver and kidney disease. This may or may not be a fact—in any case, I am not prepared to dispute it; but she continues: "This is owing, I believe, to the fashion which has prevailed, of small cut-away coats, leaving loins and stomach unwrapt, *save by the light and often thin trousers.*" Now if "A Woman" were half as well acquainted with the articles of a gentleman's attire as she pretends to be, she would know that it is usual for them to wear drawers of some woven material than which it would be difficult to find anything warmer. "The absurdity of the open coat and waistcoat" is not so patent to me as, perhaps, it ought to be; indeed, I believe that the more sedulous a person is in wrapping himself up, the more likely and apt he is to catch cold. Despite the cutting remarks about a white and stiff shirt (which by-the-by, personally, I find a great inducement to holding oneself up) I am a great admirer of the same; but I will not presume to defend the use of the "dog-collars" with which our

XUM

gilded youth at present adorn themselves (as "A Woman" seems to dvocate "muffling," I should have thought they would have met with her approval).

With regard to the convenience of trousers, did it never occur to "A Woman" that there might be some especial reasons for discarding them when indulging in particular exercises? Thus, in bicycling, running, and football a man does not put on knickerbockers because trousers impede the free use of his legs, but because, in the first case, they show his socks when riding; in the second, because the long spikes of his shoes are apt to catch in the bottoms; and, in the third case, because football is a dirty kind of game; and stockings are more easily washed.

The greater number of my rowing acquaintances go on the river in *cricketing trousers*, and I am not aware of any inconvenience attending their use. If not impertinent, I should venture to suggest that the gentleman who found it so "jolly to dance without trousers" had attracted attention by the symmetry of his calves, and regretted that he would be unable to do so on future occasions.

Similar reasons may be found for our discarding braces in athletic sports. As a rule, the "silks" require no suspension, and a belt, if used at all, is mostly for show. A pair of ordinary braces going over the jersey would look slightly out of place, and I find some difficulty in conceiving how they would be kept on without the use of a waistcoat. Unlike "A Woman," I am unable "to imagine many inconveniences attending their use." I can safely say, as far as I am concerned, that I have not experienced any. On the contrary, my experience tends in the opposite direction, and both for comfort, and from a hygienic point of view, I prefer them to the use of the belt.

There are two sides to the artistic view of the question; on one is Nature, on the other Art. I need go no further than to remind your readers that the human frame, if in its unsullied grandeur, is, of all the Creator's works, the most artistic. Consequently, I contend that the dress which best adapts itself to the *form* and requirements of that frame has the best right to be considered artistic. The mind of man has discovered for himself a dress which, I hold, fulfils both of these requisites. It remains to be seen whether the mind of woman is equal to the task of devising a similar one for herself. G. CLAVERING MESNARD.

A FEW OBSERVATIONS ON HEAT.

[856]—*First Law.*—Heat and mechanical energy are mutually convertible. A unit of heat = quantity of heat required to raise one pound of water 1° Fah. in temperature = energy required to raise 772 pounds 1 foot in height. This is expressed—

$$E = J\,Q$$

where E = amount of energy in foot-pounds,
Q = quantity of heat in thermal units,
J = 772 foot-pounds = Joule's equivalent.

Second Law.—The energy converted from one of these forms to the other during a given change in any substance, is proportional to the absolute temperature.

[*Absolute Temperature* is measured according to a scale in which equal divisions correspond to equal quantities of energy.]

This law is expressed—

$$E = J\,Q_1\frac{T_1 - T_2}{T_1}$$

where T_1 and T_2 are the initial and final temperatures.

These two laws are the result of experiments. They are also the result of any theory founded on the collisions of molecules of gases, or on the centrifugal energy of molecular vortices in solid bodies. The absolute zero so found is $T_0 = -460$ F. This zero also corresponds to that at which gaseous elasticity disappears. Thus, it is found that air expands 0·366 of its volume between 32° and 212°, hence—

$$T_0 = 32° - \frac{180°}{\cdot 366} = -460°.$$

The quantity of heat in a body when no change of state is involved is the product of the specific heat into the absolute temperature, or

$$Q = kT.$$

Sensible or thermometric heat = kinetic energy. Latent heat = potential energy = heat which disappears in molecular changes $= \frac{T(V_1 - V)}{J} \cdot \frac{dP}{dT}$, where V and V_1 are the volumes of unit of mass in the first and second states, and $\frac{dP}{dT}$ the variation of pressure per degree of temperature. This formula is arrived at as a result of the two laws. It gives 966 thermal units for the latent heat of steam at 212°, and 144 thermal units for the latent heat of ice. It predicted the fact that the freezing-point was lowered by pressure, from V for ice being greater than V_1 for water.

For perfect gases, *i.e.*, those without viscosity $\frac{P\,V}{T} = \frac{P_0\,V_0}{T_0} = \text{const.}$ Hence, if such a gas expands or contracts without communication of heat, $P\,V^{1\cdot4} = \text{const.}$ T. J. DEWAR.

MUSICAL QUESTION.

[857]—The reply to "Musical Question" (808), by G. Wolff, is very apt to mislead such persons as W. Jones, who are in want of a true one to the question proposed. Mr. Jones finds the chord of C preferable to that of C sharp. It is very evident that he has a keener musical ear than Mr. Wolff, if we are to consider the latter as one of the audience, who, he says, would be ignorant of the fact that a nocturne of Chopin, written in D flat, had been played in D natural. It also shows that the tuner had, to a certain extent, tuned the chord of C with the natural number of degrees between the notes, whilst in so doing he must have sacrificed the correctness, amongst others, of the chord of C sharp. Mr. Chatterton has given the reason very generally accepted as correct; and if it is correct, it is quite natural that those chords, the correctness of which had been sacrified to others by the tuner, would sound harsh and incorrect.

Taking the chord of C. Now the number of degrees from 3rd to 5th (E to G), should be 125, and from 5th to 8th (G to C), 197. Then take the chord of D. From 3rd to 5th should be 125, but if the piano were tuned correctly in the key of C, the number would be $\frac{197}{2} + 72 = 112$. Thus, to make the chord of D more correct, F sharp should be made 125 − 112 = 13 degrees nearer F than is usual on the piano which is tuned on the equal temperament. Taking the supposition that there are two pianos tuned so that C natural on the one should be C sharp on the other, then, if the tuner had thrown the greatest amount of error in those keys which are the least used, the chord of the key of C would become the most perfect on both pianos, and therefore, although C and C sharp on the two pianos were exactly the same note, yet the chord on that piano on which it is played as the chord of key of C, would be much more satisfying to the ear than that on which it was played as the chord of C sharp. Most of your readers have doubtless heard the song, "Some day." It seems to me in order to hear the full effect of the song, one requires it to be played on a piano that has been tuned naturally in that very key in which it is written. On most pianos (tuned to equal temperament), many of the notes in the most touching parts of the song seem to have a degree of sharpness about them which clash very perceptibly with the natural notes produced by the voice, owing to the many accidental notes which were introduced into the song. The error in one accidental note would pass almost unnoticed; but when many such accidentals are introduced, the amount of incorrectness reaches such a height as to call one's attention to it. E. A. MARTIN.

A DISCOUNT DODGE—FIGURE CONJURING.

[858]—"T. J. K.," in letter 829, page 314, says I fell into an error in my communication 812, relative to an easy way of calculating discounts. In reply, I beg to say I fell into no error whatever. I merely professed to give a method used by a late friend of mine, and I stated that method correctly. As to the absolute mathematical correctness of that method I gave no opinion, and, consequently, am not fairly chargeable with having fallen into any error. Even now I prefer my friend's method to that of "T. J. K.," inasmuch as it seems to me to be equally useful for all practical purposes, and easier to be manipulated correctly. Calculating the discount on a large invoice to the 59·200th part of a penny is cutting the thing rather too finely. I hope the wealthy Scotch publisher mentioned in page 313 of KNOWLEDGE will not get to see this correspondence, or he will be offering Mr. Proctor 2 59-200d. per line for a review instead of 2½d.

I found the other day, in a French conjuring book, a plan by means of which a person may discover a figure thought of by another party, without seeing the said figure at all. The trick, however, would, I think, present a more mysterious appearance if worked on four figures instead of upon one. As the details of this experiment may probably be both novel and interesting to many of the arithmetical readers of KNOWLEDGE, I will state them in full.

The performer gives his friend pencil and paper, and asks him to write down, *privately*, any four figures he may choose; he must then multiply these four figures by 2, then add 4, then multiply the

product by 5, then add 12, and, finally, multiply by 10. He must now hand to the performer *the final product only*, and the performer will then instantly tell him the figures he originally chose.

Thus, suppose the four figures chosen were—	5,432
×2	2
	10,864
+4	4
	10,868
×5	5
	54,340
+12	12
	54,352
×10	10
	543,520
Thus, the figures handed to the performer, on a separate slip of paper, will be	543520
From which he will deduct privately	320
	5432 | 00

Leaving, after cutting off the two last figures, 5432, the four figures originally thought of.

But then, it may be asked, whence gets the performer the 320 which forms, it would appear, the key to the trick? The rough-and-ready way of explaining this seems to me as follows:—We must suppose the figures 5432 to be fast top links in a chain; to these the performer hooks a series of other links, to the number of 320; the deducting of the 320 is then simply the unlinking of the chain, and the leaving of the four fast links as they stood at the commencement of the experiment. Thus $0\times2=0+4=4\times5=20+12=32\times10=320$. Perhaps a more learned explanation of the matter may easily be found by some of the scientific readers of KNOWLEDGE, but I give mine just for what it may be worth. I may add, the same result may be attained by deducting 25 instead of 320, slightly varying the preceding operations; thus, multiply the original figures by 2, then add 5, and finally multiply by 5; cut off one figure only to the right, and the remaining figures will be those thought of. Here we get the 25 in the same manner as the 320; thus, $0\times2=0+5=5\times5=25$. The first method, however, is, I think, preferable to this latter one; being more complicated, the trick becomes more mysterious—the great point at which the conjurer should aim. G. M.

["G. M.'s" use of symbols is rather perplexing. What the performer really does is to multiply the original number (in this case 5,432) by 100, adding to it $4\times5+12\times10$ or 320.—R.P.]

VACCINATION.

[859]—I was rather vexed to see in your journal figures extracted from the *Medical Press* which are so wrong. Mark, now, how a plain tale shall put you or them down.

108	certified deaths vaccinated is 25 per cent., not 37, to which add "doubtful," as only a small proportion of the population are unvaccinated.		
184		42½	per cent.
292	Deaths of vaccinated	67½	,,
139	Remainder unvaccinated	32½	,,
431		100	,,

I think the above the more accurate representation of the figures. CHAS. JOHNSON.

[Perhaps; but why interchange the "doubtful" (139) and the "unvaccinated" (184). In the *Medical Press*, the percentage was considered only on the undoubted cases, which, as I pointed out, was not a correct way of dealing with the matter. The actual numbers and percentages are:—

	Number.	Per cent.
Vaccinated	108	25
Unvaccinated	184	42½
Doubtful	139	32½
		100

If we add all the doubtful cases to the vaccinated, we get 57½ per cent. of the deaths among the vaccinated. But you must be a most energetic advocate of vaccination to suggest this. Do you not see what you are doing? You are assuming that so small is the proportion of unvaccinated folk, that among 139 doubtful cases (or say, even 184), not one was probably unvaccinated. It follows, according to your reasoning, that the vaccinated are nearly two hundred times as numerous as the unvaccinated; yet, instead of supplying nearly two hundred times as many deaths (or 184 for 1), they only supply about four deaths for three (or 84 for 138) among the unvaccinated. The most ardent advocates of vaccination do not claim greater protective effect for vaccination as at present managed.—R. P.]

ON THE FORMATION OF COMETS' TAILS.

[860]—The supposition that an active tail-forming comet is made up of meteoric masses, some of which consist almost entirely of matter volatilisable by the sun's heat, is in no degree invalidated by the fact that meteors consisting of such volatile material never fall to the earth.

Though it is probable that any of the matter now contained in the meteoric streams which the earth encounters in her path round the sun once formed part of the material of a comet, this matter must have long since parted with any volatile matter with which it may then have been associated.

The meteoric stones, therefore, which reach the earth must be regarded as affording evidence as to the nature of the non-volatile material only which a comet may contain. The earth would have to pass through a comet, probably quite close to its nucleus, before it could encounter masses of volatilisable matter. From my view, it is only masses of moderate size which could be carried away from the nucleus by the steam of gas setting outwards from it, and be afterwards ejected by the evaporative force into the tail; and such masses could not long be exposed to solar radiation in vacuo without quickly losing by evaporation all their volatile matter—probably before they had been carried very far into the tail. I speak of the evaporation as taking place in vacuo, for I conceive that when a meteoric mass has been ejected to some distance from the nucleus, the evaporation will take place in what may be regarded as an almost absolute vacuum.

I may again state that I nowhere advocate the view which Mr. Ranyard persists in attributing to me, that the volatilisable matter of a comet is ice. Nor is it at all essential to my view that the dimensions of the evaporating masses should be as large as a cubic metre. It will be seen from the formula I have given that the ultimate activity attained by the complete evaporation of the volatile portion of a mass depends only on the proportion which the volatile portion bears to the non-volatile portion, not on the absolute dimensions of the mass. There would, however, be a point at which the formula would not be strictly applicable, for, when the mass has become reduced by evaporation to an exceedingly small particle, the effect of the solar rays, in causing evaporation, could hardly be confined to one side only of the particle. I believe, however, that the particle might be reduced to very small dimensions before the solar heat would cause evaporation on both sides, for experiments on evaporation in vacuo appear to indicate that radiant heat, falling on an evaporating surface, is almost entirely spent in producing evaporation, and that very little heat is carried by conduction into the interior of the evaporative body. As the polarisation of the light from a comet's tail points to the conclusion that the bulk of each evaporating mass after evaporation is very minute, it will not be necessary to suppose it to have a large bulk before evaporation, in order to account for its velocity tailwards.

In conclusion, I would remark that Mr. Ranyard, in his communication to KNOWLEDGE for May 18, has not attempted to refute the argument by which I showed that the particles of mist which he supposes to form the tail of a comet could never acquire a velocity greater than the average velocity (due to their thermal energy) of the molecules of gas evaporated from them, though he still adheres to his opinion that the particles, by continually picking up fresh matter, and evaporating it again towards the sun, would be continually acquiring fresh velocity, and might ultimately acquire a velocity sufficient to account for the tail formation which, if my argument be valid, is out of the question. A. S. DAVIS.

Cheltenham, June 11, 1883.

COMETS' TAILS AND THE SUN'S SURFACE.

[861]—In an article of mine, published in "yours" of Feb. 2nd last, I endeavoured to show that comets' tails might be considered to be formed by a repulsive force acting with an intensity varying as the surface exposed, and so in small condensed particles overcoming gravity, which acts according to mass, *i.e.*, in bodies of a given density a function of the volume. I also supposed that this repulsive force was a molecular bombardment similar to that which takes place in a Crooke's Radiometer. I did not answer Mr. Ranyard and others. I derived profit from their contributions, and my own views were in a transition state. I now seek to inquire

as to what must be the condition of the outer surface of the gaseous envelope of the sun. Obviously gas is there, passing from the condition of the third to the fourth state of matter, and the mean velocity of the molecules is by Joule's equation $V = \sqrt{3\frac{r}{\rho}}$ where V = mean velocity, p = pressure, ρ = density. These terms we cannot determine, but may form an idea of the state of affairs since V for hydrogen molecules at 32° F., and 30 in. barometer pressure is 6,097 ft. per second, and thus individual molecules may be moving at a far higher velocity. Is it not thence almost a *necessary consequence* to suppose that molecules must be constantly starting off normally to the sun's surface with a velocity that must take them beyond the limits of the sun's gravitation attraction. Hence, further, such molecules will bombard *only* on the side turned *towards* the sun any particles exposed, and this bombardment will act as a repulsive force varying with the surface as theory requires. FRED. F. GRENSTED.

DO SPECIES CHANGE?

[862]—I should feel much obliged to you if you could find room for the following extract from *Tit-Bits*, and should be glad if some one would reply to the same:—

"The negroes who attended Semiramis and Rhamses are in every respect similar to the negroes now toiling amid the sugar canes of Alabama. If during 4,000 years species and races have not changed, why should we suppose that they ever should change? Why should we not take our stand on that testimony, and assert that species are unchangeable? Such has been the argument of Cuvier and his followers, an argument on which they have laid great stress, and which they have further strengthened by a challenge to adversaries to produce a single case where a transmutation of species has taken place.

"Here we show you evidence that species have persisted unaltered during 4,000 years, and you cannot show us a single case of species having changed; you cannot show us one case of a wolf becoming a dog, an ass becoming a horse, a hare becoming a rabbit. You must admit that if there were any inherent tendency to change, 4,000 years is a long enough period for that tendency to display itself in; and we ought to see a very marked difference between the species which lived under Semiramis and those which are living under Victoria. Instead of this, we see that there has been no change: the dog has remained a dog, the horse has remained a horse; every species retains its well-marked character."

R. P. B.

["R. P. B." will find that the considerations here touched upon have been carefully weighed by evolutionists, and form part of the evidence on which the modern theories of biological evolution are based. They may have been advanced, perhaps, in the present case by some naughty person anxious to show that, if negroes have remained unchanged for 4,000 years, the different branches of the human family can hardly have sprung from a single race, still less from a single pair, unless many millions of years have elapsed since the race began.—R. P.]

ORIGIN OF THE WEEK.

[863]—I have been much interested in "The Great Pyramid," and I think, perhaps, the following quotation in reference to "The Origin of the Week" may be of use:—

"Q. Curti Rufi historiarum Alexandri magni Macedonis."—Lib. viii., ab initio cap. ix. Cambridge: Pitt Press.

Book viii., ch. ix., sec. 35:—

"Menses in quinos denos discripserunt dies, anni plena spatia servantur. Lunæ cursu notant tempora, non, ut plerique, cum orbem sidus inplevit, sed cum se curvare cœpit in cornua, et idcirco breviores habent menses, qui spatium eorum ad hunc lunæ modum dirigunt—multa et alia traduntur, quibus morari ordinem rerum haud sanæ operæ videbatur."

Trans.—"They (the Indians) have divided their year into months of fifteen days each (lit. they have divided their months into fifteen days apiece), the full period (plural) of the year is (correctly) kept."

"They measure time (pl.) by the course of the moon—not, as is generally done, from full moon (lit. when the star* has filled its orb), but (from the time) when it has begun to bend its horns; and, therefore, the months of those who fix the duration of the month according to this phase of the moon are shorter. Many other customs, also, are handed down, with which it really does not seem worth while to delay my narrative."

* "Sidus = constellation = or moon sidus lunæ."—Plin. 2, 9, 6, Sec. 41.

I have copied the translation from one published by J. Hall & Son, Cambridge, translated by H. J. C. Knight.

F. LEVERTON HARRIS.

P.S.—The following translation may also be interesting.—Book viii., 9, 31:—

"There is one wild and uncouth class which they call 'wise men.' It is with them a noble deed to anticipate the day of doom. . . . ."

"33. Those who live in towns under rules of civilisation are said to be skilful astronomers (to examine skilfully the motions of the constellations), and to foretell the future—nor do they believe that one thereby hastens the day of death, since—he-can-look-forward-to it without fear. . . . ."

LETTERS RECEIVED AND SHORT ANSWERS.

JAS. STEPHENSON. It is very difficult to advise in such matters. I should have thought Guillemin's "The Heavens" more generally useful than Newcomb's book, admirable though it is. Would not Huxley's "Physiography" suit. By the way, "physiography" is an atrocious word, not in the slightest degree indicating what was intended, and almost as discreditable to science as "chromosphere."—NEMO. Guillemin's "Heavens." As to telescopes, unable to advise.—A. C. P. suggests that my notes (only they are not mine) on "The Face of the Sky" should date from two days after the day of publication, as some readers are reached later than the day for which the notes begin.—A. D. C., CANTAB. Thanks.—S. P. G. I use Boole's Dif. Equations. Other question too vague.—A. E. W. Inconsistent with curved tails.—HALLYARDS. That correspondent was answering some one who had attacked him. Do not want discussion on the point raised. Letters are not articles. One such subject started would send in on us an intolerable load of correspondence. After all, what does it matter?—G. C. LYON. Have read the cutting. Should say it was a joke; but if the person named really wrote that, I should imagine mania was about.—SAM. KINES. No, I thank you. I think I could very easily show that, with such latitude as you allow yourself, the chances are about a billion to one against your failing to find close correspondence. If "Let the earth bring forth grass" (or, *lit.*, "Let the earth sprout forth sproutage") can be interpreted "Let algæ, lichens, and fungi appear," then—well, then, anything, so to speak, might (as it were) be interpreted after a fashion anyhow. In my first book I tried something that way myself, but I know better now. As well try riding across country in swaddling-bands.—J. V. E. Thanks. The other article has been really deferred preposterously. It shall appear very soon. The other series I should much like to see. I would arrange for its speedy appearance, taking alternate weeks; for, as you say, it would be necessary not to have long delay.—ARASTHOM. Surely the discount dodge has been sufficiently explained.—JAS. A. U. M. Many thanks. See reply in "Gossip." The proofs full of interesting matter.—A. GOOD. Can no longer forward or insert questions addressed to contributors.—INQUIRER. Gravity at any point within the earth is unaffected by the attraction of all matter lying outside a spheroidal surface through the point, similar and concentric with the spheroidal surface of the earth herself.—J. A. ROBSON. Mr. Moore simply takes *b* so as to make one of the multipliers a multiple of 10.—$\frac{3}{4}$ AS.S. The moth which was flying all the time in the railway carriage covered whatever distance his journeyings within the carriage amounted to, *not*, in addition, the twenty-five miles traversed by the train. So soon as the train started the carriage-full of air was carried along, with the moth in it.—A. R. ROTCORP (in whom I seem to recognise an inverted name-sake) wishes to hear of a remedy for hay fever.—J. M. RODGER. I daresay your 13-fold trisection will do all you claim for it, and that if I suppose, multiply, subtract, divide, &c., as you tell me to, the result will be what you say. But suppose I don't?—R. F. WOOTTON. Thanks.—R. T. P. Can hardly do that.—M. H. CLOSE. Yes; some mistakes.—ALG. BRAY. There are sixteen roots of the equation besides unity. You have evidently still to study an interesting chapter of the theory of equations.—A. H. HUTH. Thanks. Will use your letter if can possibly find space.—J. W. DAWSON. Know nothing of the plans for that periodical, except that they in no way affect ours.—A. J. SANTON. Do not know any of their names, nor quite what is meant by an "astronomer-royal to the king of Bavaria." Is it some specially royal kind of astronomy they study?—G. W. B. Thanks; will consider when time comes, and space can be found.—A LEARNER. We do not work sums.—C. JOHNSTON gives, as a paradox, this—"For every person born, one, viz., himself, dies; how then can the population increase?" By way of illustration, early marriage and large families may be suggested.—W. QUINTIN desires to learn how best to chloroform a frog without injuring it.—T. J. DEWAR. Thanks. Heat seems to result from other causes than science recognises.

Our Mathematical Column.

GEOMETRICAL PROBLEMS.

By RICHARD A. PROCTOR.

PART V.

WE will now try a problem of greater length, though by no means difficult:—

Ex. 5.—*The triangles B A C, B D C (Fig. 10) are on the same base, B C, and between the same parallels, A D and B C; also, B A C is isosceles, the side B A being equal to the side A C. Show that the perimeter of the triangle B A C is less than the perimeter of the triangle B D C.*

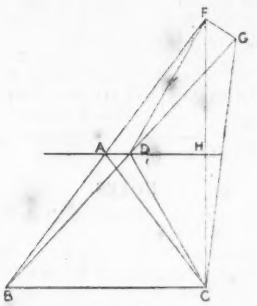


Fig. 10.

First of all, we notice that B C being common to both triangles, we need only prove that B A, A C are together less than B D, D C together.

After a little examination it becomes clear that the sides B A, A C are not easily comparable with the sides B D, D C, *as they stand*. It is an obvious resource to produce B A to A F, making A F equal to A C, so that B F is equal to the sum of the lines B A, A C; and in like manner to produce B D to G, making D G equal to D C, so that B G is equal to the sum of the lines B D, D C. We have, then, to show that B F is less than B G. If B F *is* less than B G, then joining F G, the angle G is less than the angle B F G (Eu. I., 19). But there seems no obvious method of proving this relation.

Let us consider our construction. We have A F equal to A C. But A C is equal to A B. Thus B A, A C, and A F are all equal. Hence a circle described with centre A, through B, would pass also through C and F. Since B F would be the diameter of this circle, B C F is a right angle. (Euc. III., 31.) We therefore join C F, and note that it is perpendicular to B C.*

We notice, also, that C A F is an isosceles triangle. Let us see, then, about B G. We have D G equal to D C. But D C is less than D B, since the angle D B C is less than the angle D C B. (Euc. I., 18.) This does not seem likely to help us. If we join G C, C D G is, like C A F, an isosceles triangle. But this, again, does not appear, on examination, to be a profitable relation.

Let us see, however, whether we are making use of all our data:—We have been forgetting that A D is parallel to B C. Without making use of this relation, we cannot hope to solve our problem.

We have shown that C F is at right angles to B C, and therefore, of course, C F is at right angles to A D. It will be as well, therefore, to produce A D to meet F C in H, and to note that A H is at right angles to F C. But C A F is an isosceles triangle, and it is a well-known property that the line drawn from the vertex of a right-angled triangle, at right angles to the base, bisects the base.† Thus C H is equal to H F. Will this property help us? Let us consider: C H is equal to H F, and H D A is at right angles to C F. Clearly, then, if we join D F, we have D F equal to D C, for the triangles D H C and D H F will be equal in all respects. (Euc. I., 4.)

D F being equal to D C, we may be led to proceed in one of two ways:—

First, we might notice that our construction made D G equal to D C; so that D F is equal to D G, therefore the angle D F G equal to the angle D F G (Euc. I., 5); therefore the angle B F G greater than the angle G; and B G greater than B F (Euc. I., 19); that is, B D, D C, together greater than B A, A C together.

Or, we might notice that since D F is equal to D C, B D and D F are together equal to B D and D C together; but B D and D F are together greater than B F (Euc. I., 20); therefore B D and C D are together greater than B A and A C together.

If we had followed the first of these courses, we should still scarcely fail to notice *afterwards* that the second is an available and a better solution.

We proceed, then, to run over such steps of the above work as are necessary to the proof of the proposition. In doing this we notice that a property of the third book has been made use of in proving that C F is at right angles to A H. We will assume that the proposition has been given as a deduction from the first book. Then, although the student might mentally have followed the course we have adopted,* it would be well for him to modify the proof so as to avoid the use of Book III. This is easily done. The student sees at once that the proof involves the equality (in all respects) of the triangles A H F, A H C. He had the angle A F H equal to the angle A C H, A F equal to A C, and A H common. This is not quite sufficient (so far as Euclid's treatment of triangles extends). But it is easy to supplement these data by establishing the equality of the angles F A H, H A C, these angles being respectively equal to the equal angles A B C, A C B (Euc. I., 29). Hence the triangles H A F, H A C are equal in all respects.

The construction and proof of the proposition we are dealing with run, therefore, thus:—

Produce B A to F, making A F equal to A C. Join D F, D C, and let A D, produced if necessary, meet F C in H. Then the angle F A H is equal to the interior angle A B C (Euc. I., 29). But A B C is equal to A C B (Euc. I., 5), and A C B to C A H (Euc. I., 29). Therefore the angle F A H is equal to the angle C A H. Also, F A, A H are equal to C A, A H respectively. Therefore the triangles F A H, C A H are equal in all respects (Euc. I., 4). Hence F H is equal to H C, and the angles at H are right angles. Thus the triangles D H F and D H C are equal in all respects (Euc. I., 4). Therefore D F is equal to D C. But B D and D F are together greater than B F (Euc. I., 20), that is, than B A, A F together. Therefore B D and D C are together greater than B A and A C together, and the perimeter of B D C is greater than the perimeter of B A C.

(To be continued.)

* Here is an instance of the advantage of carefully-constructed figures. The relation arrived at by a tolerably obvious line of reasoning *might* be overlooked for awhile. But if the figure has been constructed carefully, in accordance with the data, the uprightness of F C could not escape notice, and a moment's inquiry would show that it is not accidental, and suffice to exhibit its cause.

† This problem is not explicitly stated in Euclid. It is contained implicitly in Bk. I., props. 10-12. It should be included amongst the additional problems, a knowledge of which is necessary to those who wish to work successfully at deductions.

* More probably he would have *noticed* the equality of the triangles A F H and A H C, if his figure had been drawn with a moderate amount of care. He would then see at a glance that this equality was not accidental, would complete the proof mentally on the assumption that H C is equal to H F; and in writing out the proof he would give that proof of the equality of the triangles, A H F and A H C, which follows above.

Our Chess Column.

By MEPHISTO.

AN INTERNATIONAL TOURNAMENT IN GERMANY.

WE have pleasure in announcing that the bi-annual International Congress of the German Chess Association will take place at Nuremberg, beginning on July 15. The prizes for the chief tournament are £60, £40, £25, £15, £10. Besides this tournament there will be several minor tournaments, a problem tournament, solution tournament, &c. It is expected that from this country several of the strongest players will attend. Blackburne and Mason have already determined upon doing so. It will be remembered that at the last meeting at Berlin in 1881, Blackburne carried off first prize. We hope to be specially represented at the tournament, and to give our readers an ample report weekly.

THE TOURNAMENT.

Mackenzie won his game against Rosenthal on Wednesday the 20th, as announced in our columns last week. This made Blackburn absolute third prize winner. On Thursday English was fortunate enough to win from Blackburne, to whom the game was of "no consequence," but it improved English's chance for a prize; he stood at 14½. On Friday Rosenthal and English drew

their game, but on Saturday Rosenthal, who evidently had not much fight left after the two months' battle, lost to English. The latter therefore ties with Mackenzie and Mason, each having 15½. Tschigorin remained in undisputed posession of the fourth prize. Rosenthal, who oddly enough at the finish stood at 14, with four draws to play, and might have tied with Blackburne for third place, has not taken a prize at all. He had still to play Blackburne, but as he could not, even if he won, take a prize, also as the game was of no consequence to Blackburne, they did not play their game. Rosenthal has, however, won a special prize of £25, he having made the best score against the prize winners, viz., 5½, which figure includes two well-fought games won of Steinitz.

PRIZE WINNERS:

		Score.
First	(£300)...Zukertort	22
Second	(£175)...Steinitz	19
Third	(£150)...Blackburne	16½*
Fourth	(£125)...Tschigorin	16
Fifth	(£100) } Mason	15½
Sixth	(£75) } Mackenzie	15½
Seventh	(£50) } English	15½

Special prize of £25 for best score against prize winner:—Rosenthal.

* One game unplayed.

COMPLETE SCORE TABLE.

	1st Round	2nd Round	Total		1st Round	2nd Round	Total
Bird	7	5	12	Rosenthal	7	7†	14
Blackburne	8½	8†	16½	Sellman	3½	3	6½
English	7	8½	15½	Skipworth	3	retired	
Mackenzie	5	10½	15½	Steinitz	9	10	19
Mason	9½	6	15½	Tschigorin	9	7	16
Mortimer	0	3	3	Winawer	7½	6	13½
Noa	3½	6	9½	Zukertort	12	10	22

† One game not played.

We think the play of Captain Mackenzie deserving of special notice. We pointed out in a former number the inconsistency between his position at the London and Vienna Tournaments in the first rounds. Since that time he has at least shown us the consistency of his inconsistent play. In the first round, as will be seen, he scored 5, while in the second round he not only scored more than double, viz., 10½, but he has absolutely done better than anybody else, and has beaten Zukertort.

A most remarkable decline in position is revealed to us by Winawer's score. It would be almost incredible, if it were not a fact, that from being first at Vienna with 24, he has descended to eighth in this tournament with 13½.

English steadily advances in strength, although his play is not sufficiently spirited to be capable of very great improvement. He was close upon the prize winners at Vienna; this time he has done better. He is a remarkably rapid player, but very much given to drawing. Kolish said of him that it is very difficult to win a game from him, but also difficult to lose one.

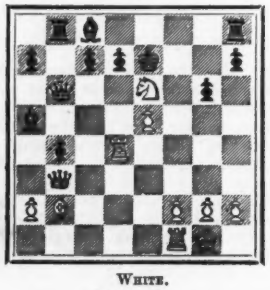
We are glad to see Blackburn come out at the head of all other players in such an important contest; barring Zukertort and Steinitz. His position is a very honourable one.

MORTIMER'S VICTORY.

Position after Black's 21st move.

MORTIMER.

BLACK.



WHITE.

ZUKERTORT.

White. Zukertort.	Black. Mortimer.	White. Zukertort.	Black. Mortimer.
1. P to K4	P to K4	23. R takes P (ch) (*f*)	K takes R
2. Kt to KB3	Kt to QB3	24. Q to B7 (ch)	K to B sq
3. B to B4	B to B4	25. P to K6	B to R3 (*g*)
4. P to QKt4	B takes P	26. R to QB sq	R to Q sq
5. P to B3	B to R4	27. P to K7	K to Kt2
6. P to Q4	P takes P	28. P takes R, Q'sR	takes Q
7. Castles.	P takes P	29. Kt to K6	R to Q4 (*h*)
8. Q to Kt3	Q to B3	30. B to B6	Q to B3 (*i*)
9. P to K5	Q to Kt3	31. R to R sq.	B to QB5
10. Kt takes P	KKt to K2	32. Q to K7	Q to Q3
11. B to R3	R to QKt sq (*a*)	33. Q takes Q	R takes Q
12. Kt to Q5	Kt takes Kt	34. Kt to B5 (ch)	K to B3
13. B takes Kt	Kt to Q sq	35. Kt to K4	R to K3
14. QR to Q sq.	P to QKt4 (*b*)	36. P to B3	B to Kt3 (ch)
15. R to Q4	P to Kt5	37. K to R sq	B to Q4 (*j*)
16. Kt to R4	Q to QKt3	38. R ch	K to Kt4
17. B to Kt2	Kt to K3 (*c*)	39. B to Kt5	B takes Kt
18. Kt to B5	P to Kt3	40. P takes B	R takes P
19. B takes Kt	BP takes B	41. P to KR4	P to KR3
20. Kt to Kt7 (ch)	K to Q sq (*d*)	42. B to Q8	P to B4
21. Kt takes KP (ch)	K to K2	43. Resigns.	
22. Kt to B4 (*e*)	B to Kt2		

NOTES.

(*a*) Played by Andersen. If B takes Kt or Castles, then QR to Q sq gives White a good attack.

(*b*) Or Kt to Q3 at once.

(*c*) Castling would not be good, as White would get up an irresistible attack by Q to Kt3.

(*d*) The position is very complicated and interesting. If K to K2, then Q to Kt3; or if K to B2, then Q to B3 (ch); K takes Kt. Q to B6 (ch), K to Kt sq. R to B4, and wins.

(*e*) Kt to Kt5 ought to give White an easy win. We give a diagram of this interesting position.

(*f*) Then, again, P to K6 ought to win, instead of going in for brilliancy.

(*g*) A very good move.

(*h*) Black now has the best of it. If R takes P (ch), Q takes R, threatening mate by R on Q8; or if Kt takes P, then R to KB4.

(*i*) Taking the bull by the horns.

(*j*) Which wins another Pawn and the game.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

LEONARD B. PAGE.—1. R takes KP; time, five minutes.

ALFA.—Blackburne has proved himself the best English player.

JACOBS.—Anything to oblige a lady.

BONA FIDES.—See notice.

R. S.—We do not think it necessary to go into the particulars of your variation. P to KKt3, whether played as defence to the Ruy Lopez or the Two Knights' Opening, must be bad on principle. P to KB5 mostly is the straw that breaks the camel's back.

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